POTENTIAL HAZARDS OF SEDIMENT IN KENDARI BAY, SOUTHEAST SULAWESI

By :

N.A. Kristanto[1], Y. Noviadi[1] and P. Raharjo[1]

ABSTRACT

Kendari bay is located in front of Kendari city. There are two harbors in the inner part of bay which very important to support economic activities such as shipping and passenger transportation.

The result of coastal characteristic mapping and physical oceanography survey show various coastal morphology, vegetation, weathering processes, sedimentation, currents, and water depth and sea floor morphology.

Kendari bay is an enclosed bay; the area is wide in the inner part and narrow in mouth of bay (outlet), the morphology look like a bottle's neck. Numerous mouth rivers are concentrate around the bay.

The rivers load material from land since erosion on land is intensive enough. There is indication that sediment supplies from land trough river mouth not equivalent with outlet capacity. Sediment load is trapped in the inner bay caused the outlet morphology. So high sediment rate play an important role in the process of shallow of water depth in Kendari bay.

This condition make the Kendari bay is a prone area of sediment hazard due to height rate of sedimentary process. Therefore, to anticipate the hazards, precaution should be taken related to the Kendari bay as the center of activities in southeast of Sulawesi.

The further survey is needed such as marine geotechnique and on land environmental to collect data, which can be used as database for development planning.

Key words: Potential hazard, sediment, Kendari Bay

SARI

Teluk Kendari terletak di bagian depan kota Kendari. Di bagian dalam teluk terdapat 2 pelabuhan yang sangat penting untuk menunjang kegiatan ekonomi seperti perikanan dan transportasi.

Hasil pemetaan karakteristik pantai dan penyelidikan oseanografi memperlihatkan kondisi morfologi pantai, vegetasi, proses pelapukan, sedimentasi, arus, kedalaman air laut dan morfologi dasar laut.

Teluk Kendari merupakan teluk tertutup yang lebar di bagian dalamnya dan sempit di bagian mulutnya dimana morfologinya terlihat seperti lehar botol. Beberapa mulut sungai terkosentrasi di sekitar teluk.

1. Marine Geological Institute, Ministry of Energy and Mineral Resources, Bandung, Indonesia

Sungai bermuatan material dari daratan selama erosi didaratan cukup intensif. Hal ini mencerminkan indikasi suplai sedimen dari darat melalui muara sungai tidak sama dengan kapasitas pengeluaran. Muatan sedimen terperangkap di bagian dalam teluk dan menyebabkan terbentuknya morfologi cerobong. Tingginya muatan sedimen merupakan proses yang penting terjadinya pendangkalan di Teluk Kendari

Kondisi tersebut menyebabkan Teluk Kendari cenderung merupakan daerah yang akan mengalami bahaya pendangkalan akibat tingginya proses sedimentasi. Oleh karena itu untuk menanggulagi bahaya tersebut, harus dilakukan pencegahan karena Teluk Kendari merupakan pusat kegiatan di Sulawesi Tenggara.

Penelitian selanjutnya seperti pengumpulan data geoteknik kelautan dan lingkungan sangat diperlukan untuk dijadikan data dasar untuk rencana pengembangan.

Introduction

Kendari bay is situated between longitude 122° 30’ E – 122° 50’ E and latitude 3° 53’ – 4° 10’ S (**Figure 1**). The problem of sediment hazard in this area is predominant. The survey of marine geology and geophysics, coastal geology mapping were carried out in order to

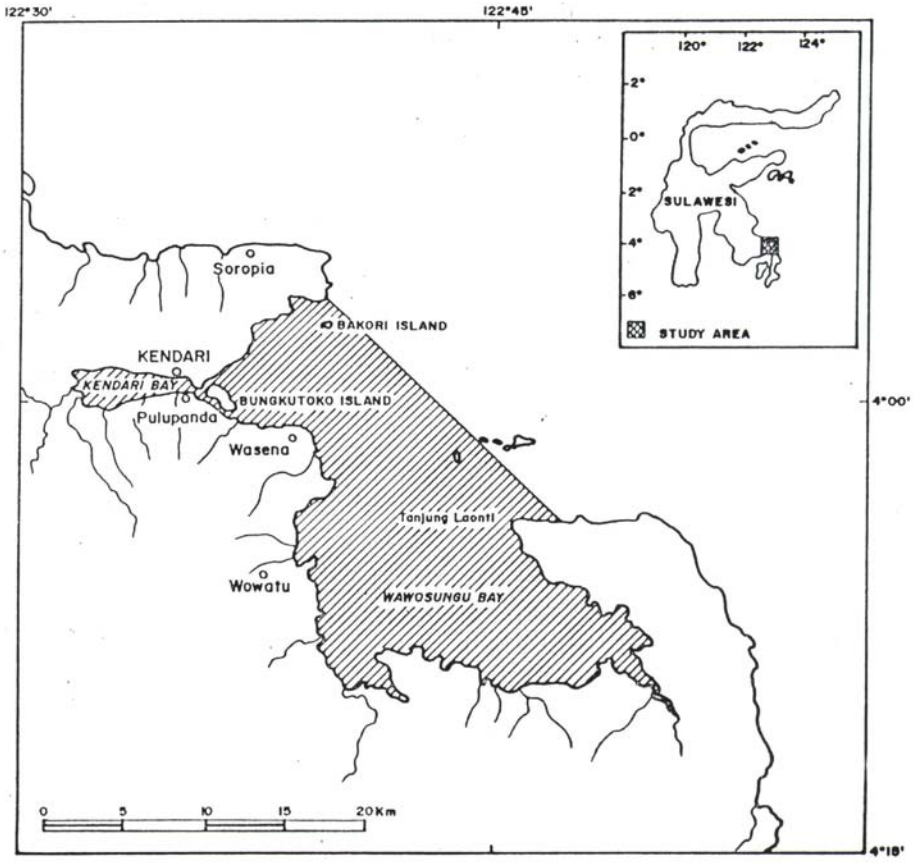

Figure 1. Location of the study area

collect basic data on geological and geophysical aspects.

The purposes of marine geological and geophysical survey are to obtain the information of sea floor surface sediment; current behavior; and to take sea floor morphology and sea bottom profiling. Coastal geology survey to gets topography, drainage pattern and vegetation.

We discus structural geology, sea floor sediment, sea floor morphology, current direction and velocity, coastal characteristic and its dynamic including topography, on land vegetation and erosion processes.

Methods

Methods used in this research as follow:

- References studies
- Field activities i.e.: ***1***. Coastal geology survey emphasis on studies the type and physical properties of lithology, relief and shoreline characteristics; *2*. Sampling of sea floor surface sediment of Kendari bay and Wowosungu bay using gravity corer and grab sampler; *3*. Carry out the bathymetry survey, applying echo sounder equipment; *4*. Measurement of current direction and velocity during the tide cycle, the measurement was conducted around the mouth and the center of Kendari bay; 5. Seismic survey, using uniboom EG & G type 230 with output of 200 joule and pulse repetition rate of 0.25 sweep/ second.
- Data processing
- Writing the paper

Results

Topography, drainage pattern and vegetation

Kendari bay is an enclosed bay; the area is wide in the inner part and narrow in mouth of bay (outlet). Kendari bay is surrounded by rough undulated hills. Numerous rivers mouths are concentrate around the bay (**Figure 2**). Land use of the hill areas is agriculture and settlement. For the greater part of the hill area had been deforest and consequently land erosion has become intensive especially during the rainy season. Most of material yields from erosion deposited in Kendari bay.

The Coastal Dynamic and Characteristic

The coastal survey shows the several of coastal processes and morphology. The various in coastal processes and morphology are results from the interaction of geological and oceanographically factors such as rock's resistance, morphology, wave action, and water current.

Figure 3 showing the coastal characteristics map. Generally coastal characteristic can be divided as following types:

Type I

This type covers the inner part of Kendari bay. Geologically, the coastal area consists of alluvial deposits and sandstone with low to medium resistance. The topography of the area dominated by low to medium relief. The coastline built by mudflat, mangrove and boulders of sandstone. Mudflat area occurs in the west and east Kendari. These areas have been developed as a fish ponds and settlements. Mudflat areas is widening during low tide in the shore direction.

Type II

This type is mainly spread in the outer part of Kendari bay. The rock's kinds in the northern part are alluvial deposits where as in the southern part composed by sandstone, limestone and metamorphic rock.

Topography of the area dominated by flat to medium relief. Outcrop, boulder, sands beach and coastal plants dominate the coastline's lithology.

Type III

This type covers around the coast of Wowosungu bay. Topographic characterized by medium to low relief. Fresh and indurate metamorphic rock dominated the coastline lithology. Coastline is characterized by out crop and coastal plant.

Sea Floor Morphology

Base on bathymetric map (**Figure 4**), the bathymetric contour follows coastline shape. Sea floor morphology is rough undulation. It is probably caused by domination of hard rock affected by geological structure. The deepest part has depth 30 meters in the eastern part of Kendari bay. To the west, the depth of sea bottom is shallower. It is about 10 – 20 meters. At the center part of the bay, sea bottom is shallow to the coastward direction. The shallowest is about 1 – 10 meters depth.

Current Direction and Velocity

Generally, current direction is related to high and low tide. During the low tides, current is in eastward direction, while during the high tides in opposite direction. It is westward. Base on the current velocity measurement, Current velocity in the mouth of bay is about 0.2 m/sec. Where as in the center and around the upstream of the bay is about 0.6 m/sec. (**Figure 5**)

This condition perhaps associated with the sea bottom morphology that relatively shallow and also possibility due to the existence of Bungkutoko island located in front of the mouth of Kendari bay.

Commonly, the seawater circulation is strongly influenced by tide. This condition is shown by salinity variations with the depth of seawater is more homogenous. Due to the current circulation the sediment transported by the river were deposited around the bay.

Distribution of Surface sediment

Numerous of 122 selected samples were analyzed on grain size. The results of analysis can be summarized as follow (**Figure 6**):

Silt

Silt covers the western part of Kendari bay and in almost entire Wowosungu bay. Greenish gray color, soft and plastics generally characterize this sediment, consist of mollusk shell, micro fauna and abundant of organic remains. The statistical parameters of the grain size analysis gave the variation of the shorting 0.9 – 1.5; skew ness –0.8 - +0.8 and kurtosis 2.3 – 5.3.

The value variations of the skew ness show that the deposition of the silt was perhaps influence by the river and marine environments. The silty sediment, which deposited in Kendari bay commonly influenced by river energy. The distributions of these sediments are closely related to the intensive erosion in the onshore area.

Gravely mud

Gravelly mud found in the center part of Kendari bay. This sediment is generally blackish gray color, very soft, medium plasticity; consist of mollusk shell and micro fauna. Gravels consist of coral, sandstone, igneous rock and metamorphic rock. Statistical parameters of the grain size analysis gave the variation of sorting 1 – 13, skew ness –0.1 - -0.8 and kurtosis 3 – 7.3.

The variation of skew ness indicates that these sediments were deposited under the influence of marine processes.

Gravely sand

Gravelly sands were encountered in the northern – southern part and also around the mouth of Kendari bay. In general these sediments are brown in color, loose, medium to coarse in size, consist of coral reef

fragments, quartz and other litho fragments such as sandstone and igneous rock. The statistic analysis shows that these sediments are influenced by marine energy.

Gravelly muddy sand

These sediments were deposited in outer part of Kendari bay. Sands and gravels are fragmented from coral reef where as mud fraction was interpreted as suspended material, which derived from onshore deposits.

Gravelly sandy mud

These sediments are extended around the Wowosungu bay. Commonly the mud friction has gray color, soft and medium plasticity. It was presumed that most of mud fraction to be scattered from onshore material which transported by river energy. On the other hand, sand and gravel are derived from coral reef that grow around the coast.

Coral reef

Coral reef developed at shallow depth around the coast and near Bukori island extending to the southern part. The coral grows intensively in pure natural environment.

Shallow seismic reflection data

High resolution of single channel seismic reflection data were collected from over 75 km of track line with grid spacing about 0.5 km parallel and a cross the shore line. Interpretation was done based on the seismic sequence and seismic facieses analysis. **Figure 7** shows the two locations of track line. The result of seismic interpretation as follow:

Profile I (Cross Section C – D, Figure 8)

The profile running across the outer part to the inner part of Kendari bay. Morphology of sea bottom's surface is rough undulated topography. In common, sequence can be distinguished as follow:

The lower most sequence was supposed as a Pleistocene sediment pile, which is characterized by continuous sub parallel reflector of high amplitude. From this configuration, the Pleistocene sediments are evidently dominated by hard and compact sedimentary rock. This sedimentary pile is overlain by Recent sediments I which only developed in the area between time 6.30 and 6.32. This shows that the sedimentation processes are more intensive in the inner part of Kendari bay.

Sedimentary processes have not developed in outer part of Kendari bay it is possible because the sea bottom morphology around the area is undulating while the current velocity in inner part of the bay is relatively low. More over, the undulating seabed morphology is acting as a dam against sediment transport. Therefore, The Recent sediment was only deposited in the inner part of Kendari bay.

The Recent sediment I are shown as a transparent reflector, low amplitude and interpreted to be relatively dense sediment.

The sediment Recent II which is overlain by sediment Recent I characterized by a continuous parallel reflector of relatively high amplitude.

Profile II (Cross Section A – B, Figure 9)

Profile II, cross-section A – B was drawn in the inner part of Kendari bay in south – north direction.

Five sequences were recognized as follow:

The lower most sequence is considered to be a seismic basement characterized by an undifferentiated reflector configuration and also by northward dipping direction.

Pleistocene sediments that are characterized by a continuous sub parallel and high amplitude reflection configuration overlie the sequence.

In the upper part of the Pleistocene sediments are assigned to sediment Recent I.

The sequence is marked by continuous sub parallel and medium – high amplitude reflector configuration. This shown that these sediments are perhaps dominated by medium to coarse fraction, moderately dense and deposited by current of medium to high energy. The upper most layers are formed by sediment Recent II. The reflector configuration of this layer is characterized by continuous parallel transparent and low – medium amplitude.

Discussion

From the seismic record it is possible to detect the sedimentary processes. In the first stage, the Kendari bay could be formed due to the horst and graben structure, and this can be recognized at the bottom of the Present sea floor.

According to the correlation with the geological setting of the surrounding area, this structure probably developed during Late Neogene – Early Quaternary that is evidenced by the Pliocene to Pleistocene Sulawesi Mollase being effected by the structure. After the old sea floor was formed erosion processes was transported and deposited in Kendari bay. Base on the seismic profile, these sediments were interpreted as Recent sediment I. Seismic stratigraphy analysis shows that the Recent sediment I is characterized by continuous sub – parallel and relatively high amplitude reflector. Therefore, it can be interpreted that the Recent sediment I is dominated by the medium to coarse fraction.

Furthermore, sedimentation processes were continuously together with the erosion processes on land. The second stage of the sedimentation processes may be discerned in seismic reflection profile as a Recent sediment II.

The seismic reflection record shows that at the first stage, the depth of the sea floor is about 32 meters below sea level and the depth of present day sea floor is about 16 meters below sea level. This evidence shows that the Kendari bay has undergone shallow process as much as 16 meters.

The erosion processes occurring on land also plays an important role in the shallow process of the Kendari bay. If this processes is not be reduced, the Kendai bay will become shallower in the future.

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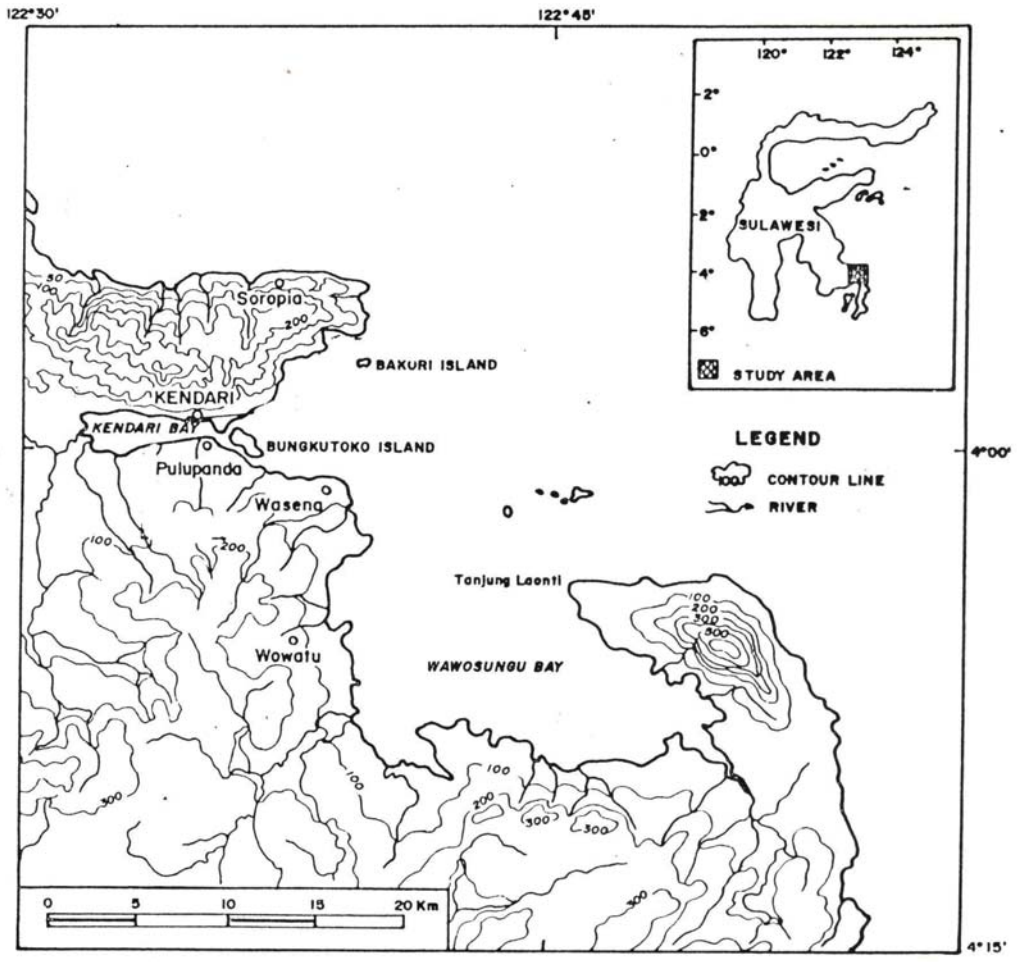

Figure 2. Topografi and drainage pattern of study area

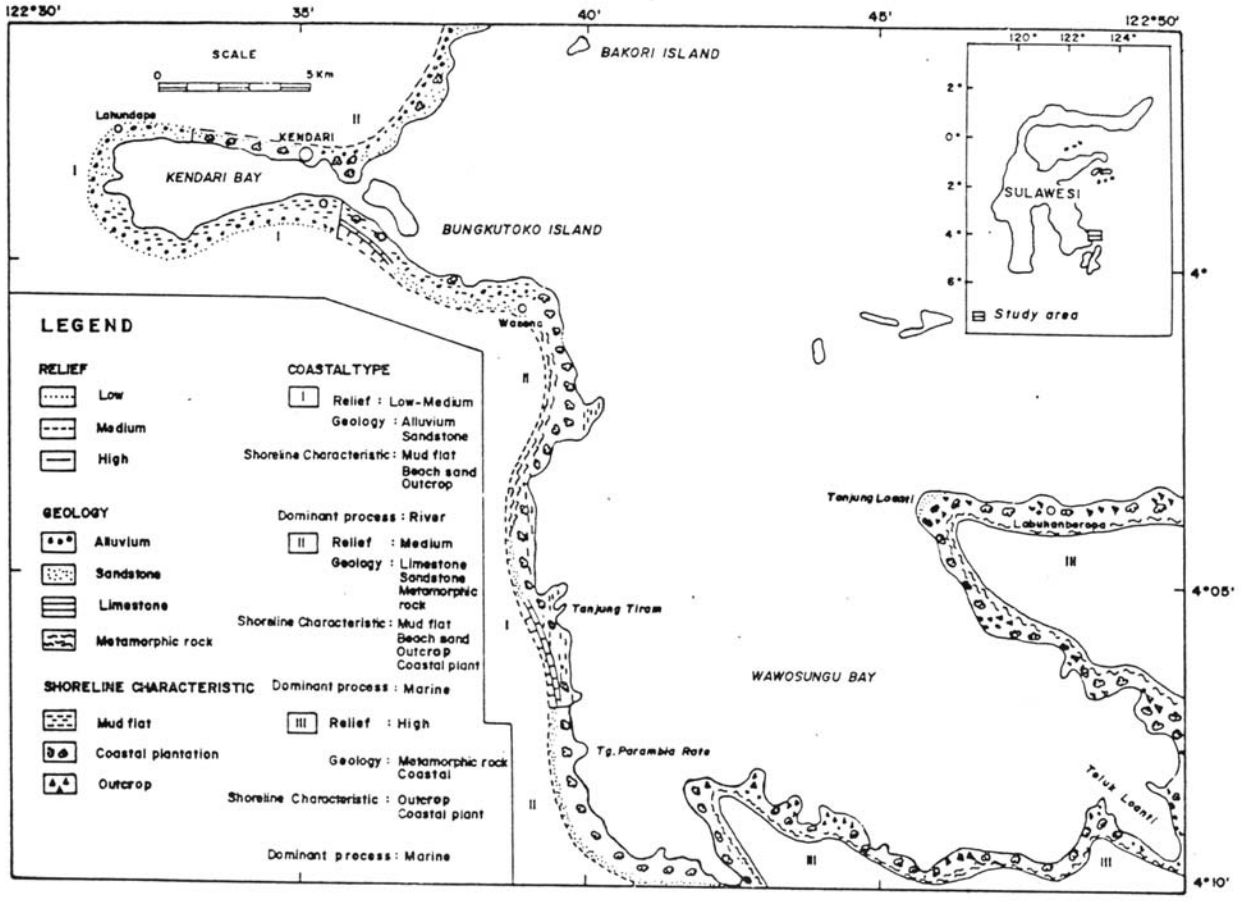

Figure 3. Coastal characteristic map of Kendari and Wowosungu Bays

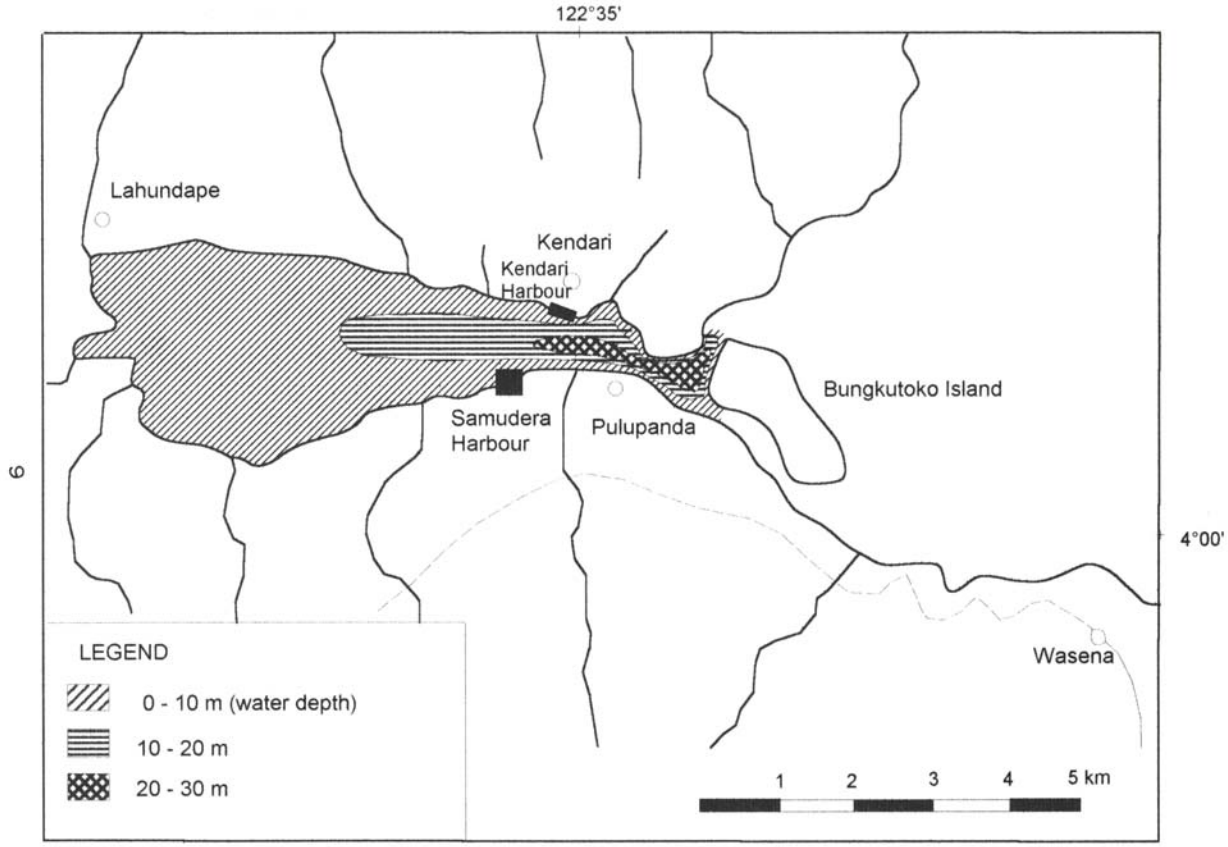

Figure 4. The water depth range of Kendari bay

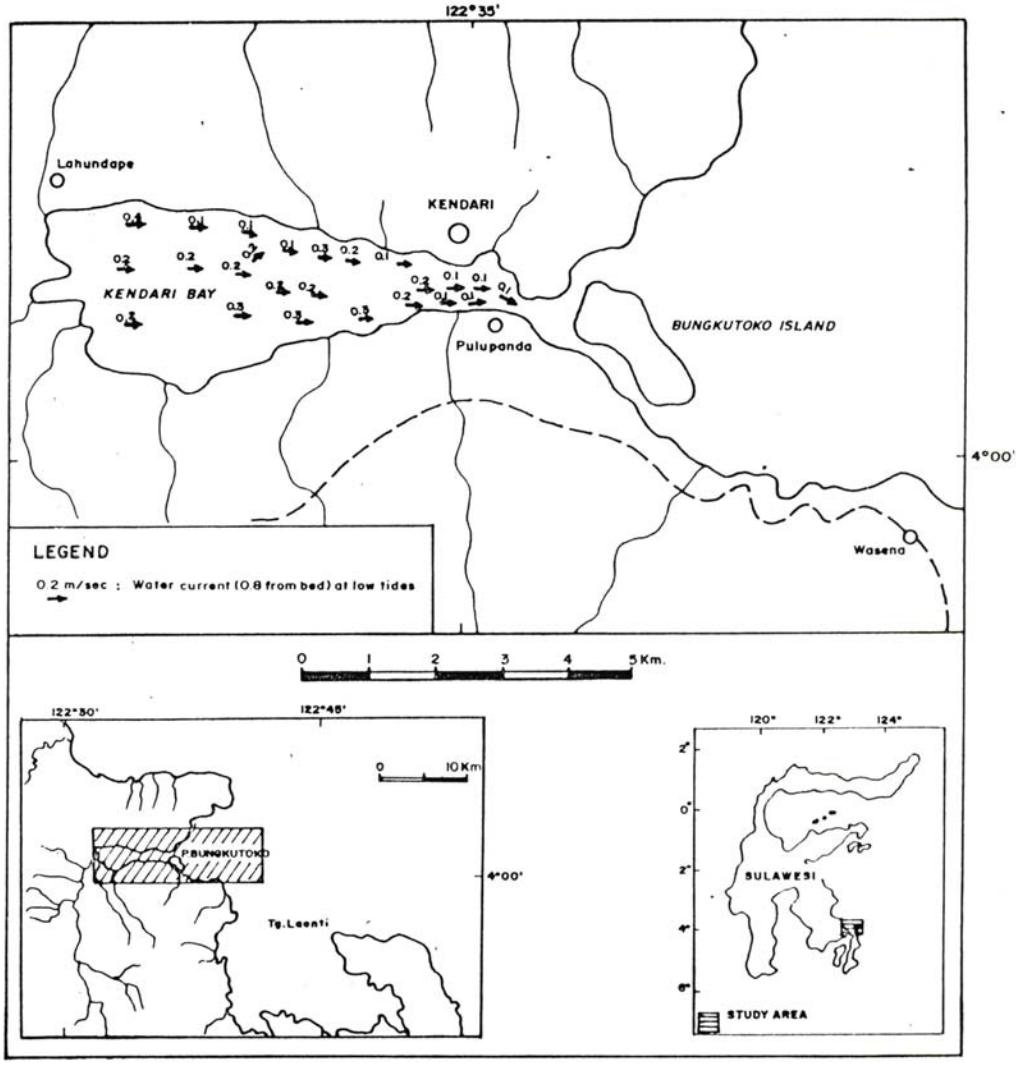

Figure 5. Current direction and velocity at Kendari bay

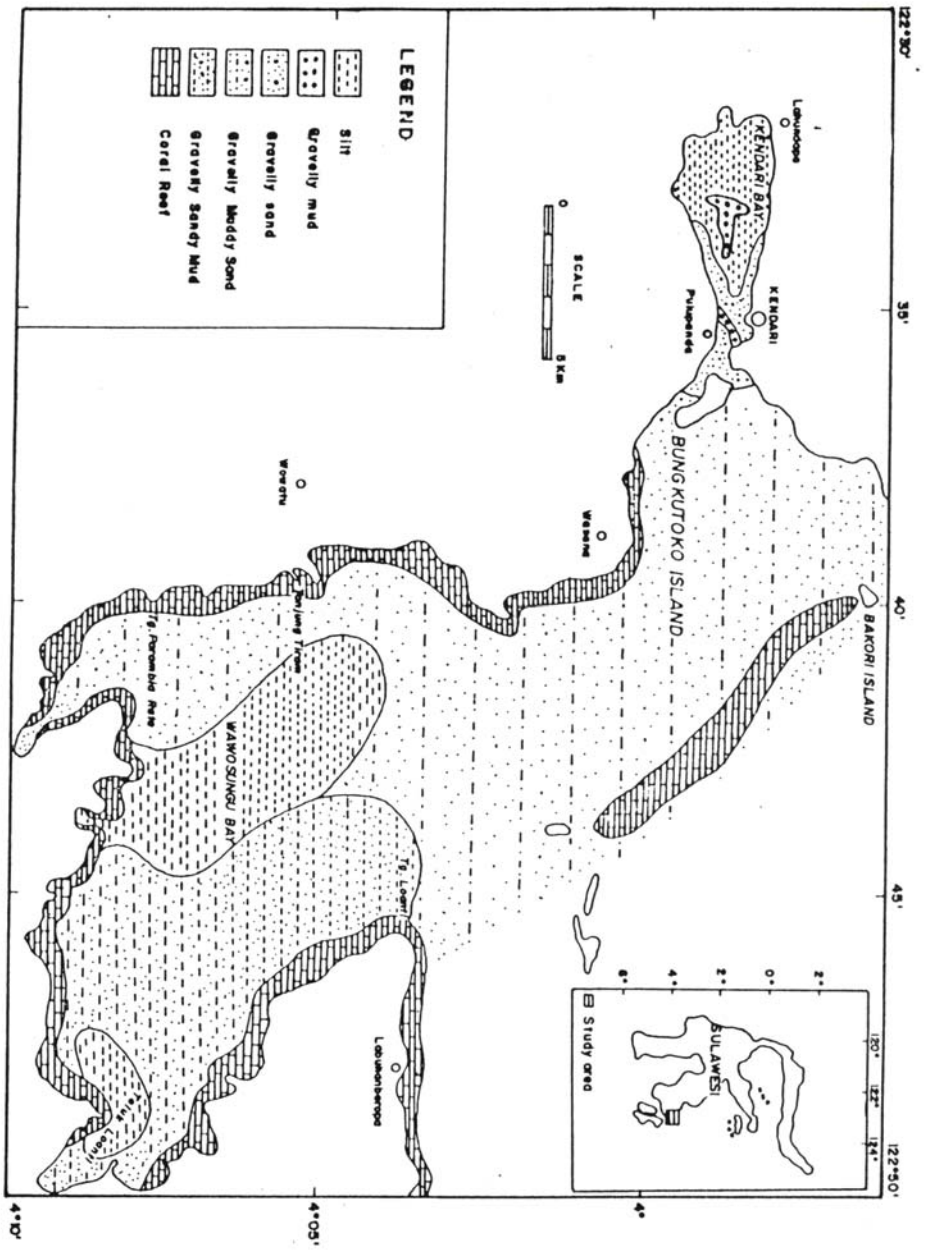

Figure 6. Surficial sediment map of Kendari and Wowosungu Bays

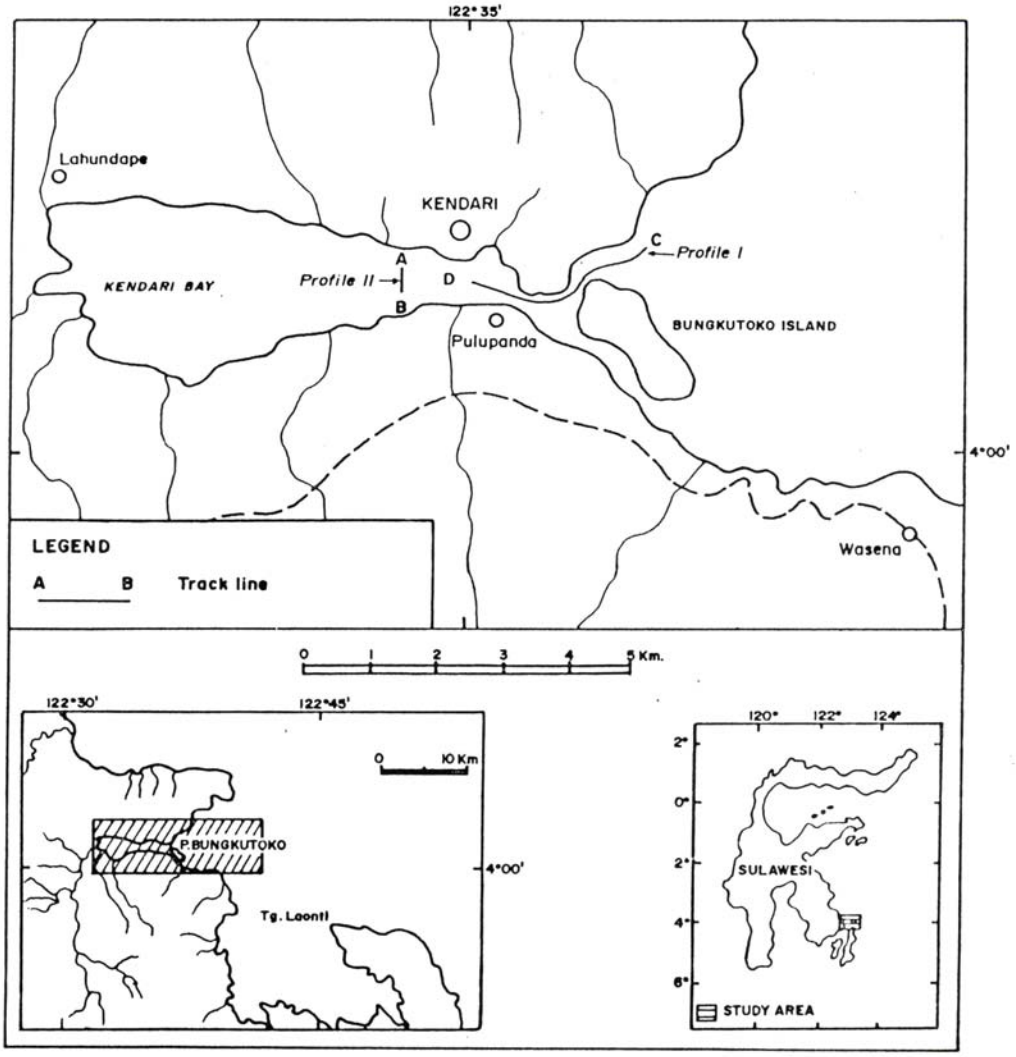

Figure 7. Some of the track line of the shallow seismic reflection at Kendari Bay

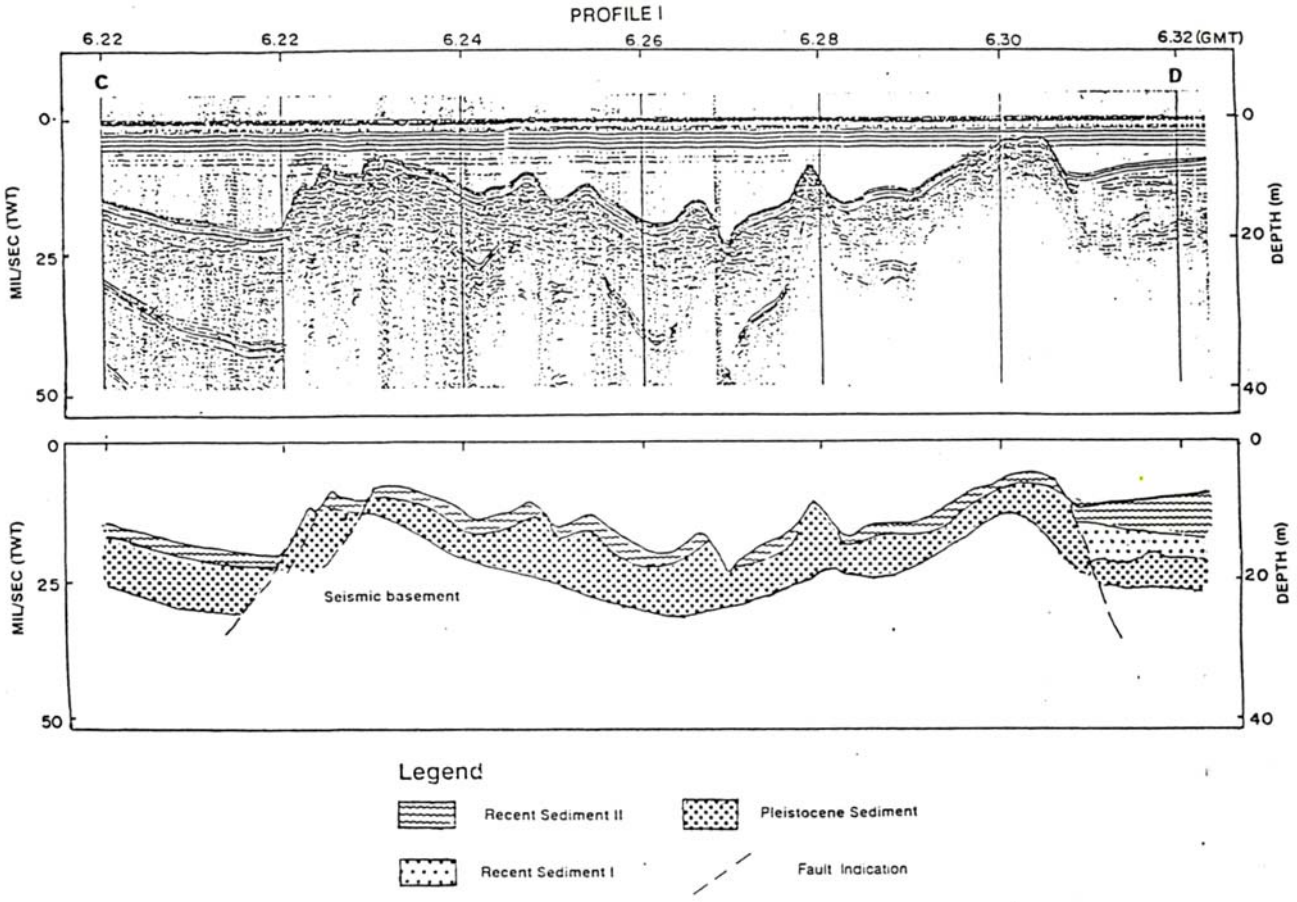

Figure 8. Seismic reflection profile and line drawing interpretation of profile I

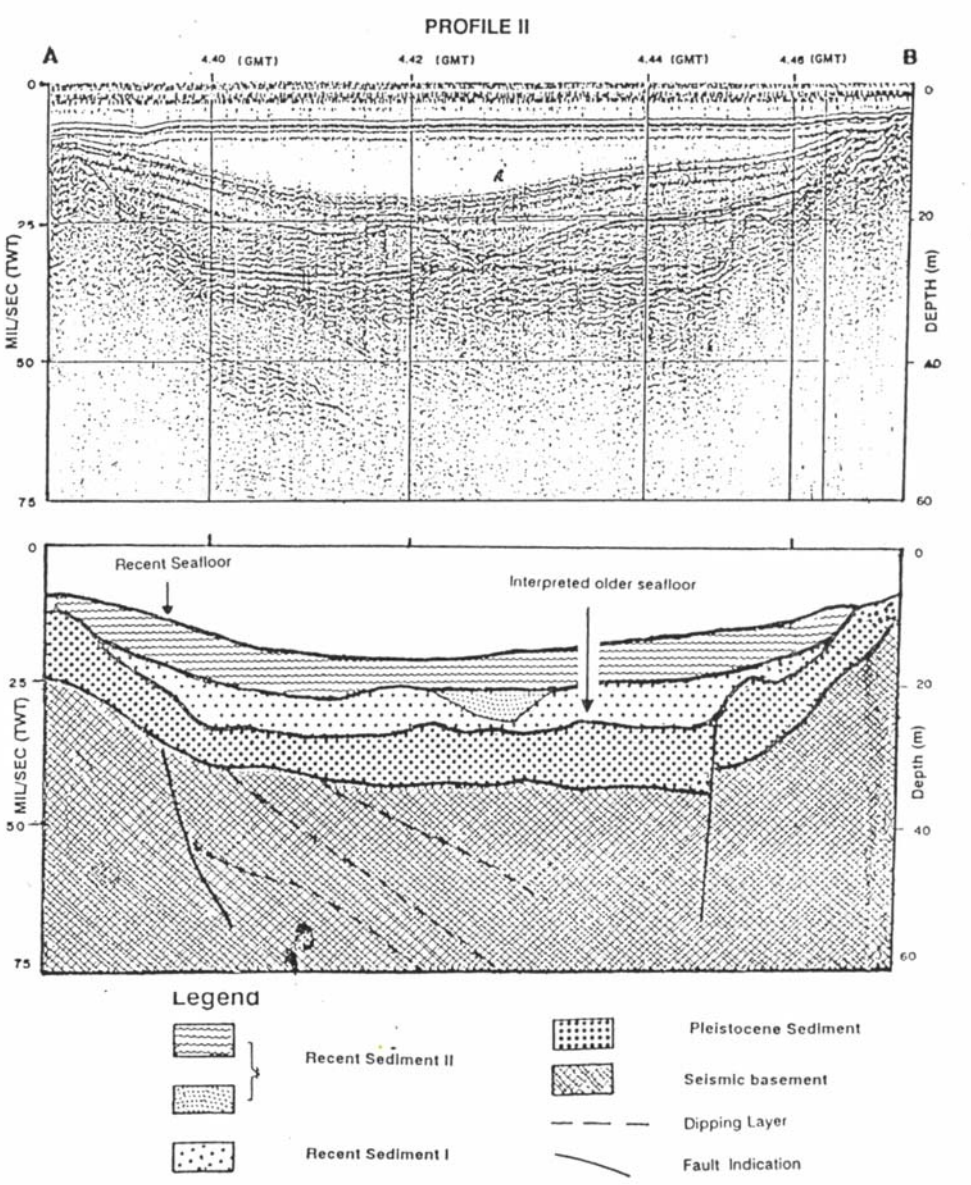

Figure 9. Seismic reflection profile and line drawing interpretation of profile II